DYNAMICALLY ADAPTING PROVISION OF NOTIFICATION OUTPUT TO REDUCE USER DISTRACTION AND/OR MITIGATE USAGE OF COMPUTATIONAL RESOURCES

BACKGROUND

Humans may engage in human-to-computer dialogs with interactive software applications referred to herein as "automated assistants" (also referred to as "digital agents," "chatbots," "interactive personal assistants," "intelligent personal assistants," "conversational agents," etc.). For example, humans (which when they interact with automated assistants may be referred to as "users") may provide commands and/or requests using (i) spoken natural language input (i.e. utterances), which may in some cases be converted into text and then processed, and/or (ii) by providing textual (e.g., typed) natural language input. Typically, in order for an automated assistant application to generate a desired response on behalf of a user, the user and the automated assistant application must correspond over multiple interactions. For instance, a user can provide, to an automated assistant application, a spoken input that describes content of a responsive message to be transmitted by the automated assistant application to a contact. Prior to transmitting the responsive message, the automated assistant may reiterate the received input from the user to ensure the accuracy of the received input. When such interactions take place while the user is engaged in an activity, such as driving a vehicle, the user can become distracted, thereby creating a dangerous situation for the user. Additionally, requiring an automated assistant application to undertake multiple interactions with a user in order to accomplish a task can waste computational resources at a computing device that hosts the automated assistant application, waste computational resources at other device(s) that supports the functionality of the automated assistant application, and/or waste network resources (e.g., at a client device(s) and/or a network device(s)) consumed in transmission of data (e.g., audio data) related to the multiple interactions.

Some automated assistants can additionally and/or alternatively provide various notifications to a user, and typically provide such notifications upon receipt. The notifications can include, for example, notifications from a device that is separate from a device executing an automated assistant application, notifications from applications that are separate from the automated assistant, and/or notifications from an operating system of the device executing the automated assistant application. However, a user may ignore the notifications, not comprehend the notifications, and/or otherwise not address the notifications, at least at the time of receipt. As a result, the user may need to interact with the automated assistant (and/or other applications) at a later time in order to address any previously presented notifications that were not addressed by the user at the time of receipt. This can lead to computational resource and/or network inefficiencies, as the notifications are ignored upon initial provision, and must be provided again following the initial provision.

SUMMARY

Implementations of the present disclosure are generally directed to methods, apparatus, and computer-readable media (transitory and non-transitory) related to an automated assistant application that dynamically determines whether, when, and/or how to present various notifications to a user. The dynamic adaptation of whether, when, and/or how to present various notifications can reduce distraction, thereby increasing user safety—and/or can result in a reduction in quantities and/or extents of provided notifications, thereby reducing consumption of various computational resources utilized in the provision of notifications. In some implementations, an automated assistant application can determine whether to: (i) fully present a notification, such as a text message, (ii) provide a condensed version of content of the notification, (iii) suppress the presentation of the notification (or condensed version thereof) until the user is less distracted, (iv) automatically respond to the notification (optionally with delayed provision of any aspect of the notification, or without provision of any aspect of the notification), or (v) fully suppress the notification. Additionally or alternatively, the automated assistant application can select an output modality (e.g., sound, image, video, vibration, and/or any other medium) via which to provide a notification (or condensed version thereof). In some of those implementations, whether, when, and/or how to present a notification can be based on one or more of: a predicted current level of engagement of the user, a predicted future level of engagement of the user, one or more properties of the notification (e.g., content of the notification, a "type" of the notification, a source of the notification), and/or a time that the notification is received. In some versions of those implementations, the predicted current level of engagement of the user can be based on various sensor data (e.g., from one or more vehicle sensors of a vehicle of the user and/or from one or more client devices of the user), a route that is being navigated by a vehicle in which the user is an occupant (e.g., when the user is the driver), application data, and/or other data.

In implementations set forth herein, an automated assistant can determine when and/or how the user would most likely comprehend and/or address certain notifications, and provide notifications based on such determination(s). By providing notifications in such manners, computational resources can be preserved by mitigating the occurrences of notifications being provided to a user at a time when the user is distracted and would not comprehend and/or address the notifications. Accordingly, providing notifications in such manners decreases a quantity of occurrences of recalling of unaddressed and/or non-comprehended notifications at a later time, thereby conserving computational resources that would otherwise be utilized in again providing the notifications at the later time. Additionally or alternatively, by adapting a format, timing, and/or any other property of the presentation of a notification, potentially dangerous and/or distracting situations affecting the user and/or other persons can be avoided. Furthermore, adapting notifications in such ways can improve the quality of notifications. For instance, when presentation of a notification is delayed until a user is idle or not traveling, less resources can be spent collecting contextual data, thereby allowing more resources to be used in the presentation of the notification, as well as to effectuate a faster response to the notification.

As one example of implementations described herein, assume a user is driving a vehicle and that a text message is received at a given time by a computing device of the user when the user is driving. An automated assistant application (associated with the computing device and/or an additional computing device paired with the computing device) can determine whether, when, and/or how to provide, for presentation to the user, content that is based on the text message. The determination can be based on current and/or future predicted levels(s) of engagement for the user and/or based on content of the text message. For example, if data